Non-destructive monitoring of high value compounds by spectroscopic sensors in microalgae photobioreactors

***Keywords**: Bioprocess, Microalgae, High-value compounds, online monitoring*

Microalgae are a versatile source of high-value compounds for various markets such as pharmaceutics, cosmetics, food and aquaculture [1]. They are typically cultivated as planktonic cells in closed photobioreactors or in raceways. Despite microalgae potential, their farming at the industrial scale remains a small niche in the market economy, primarily due to the high energetic costs associated with both upstream (e.g. cultivation) and downstream processes (e.g. molecule extraction/purification).

The automation of cultivation systems could lead to more resilient and cost-effective processes that could allow microalgae market to globally expand. Therefore, an efficient and "smart" monitoring of microalgae culture properties is of paramount importance. Sensors, which allow a continuous monitoring of culture's health state and/or molecules production are the basis of automation (Fig. 1). Up to date cultures are seldom monitored online and destructive sampling is still carried out at the lab and at the industrial scale, due to the absence of easy-to-use on-line/in-line systems [2]. However, destructive sampling is time consuming and cannot allow a continuous monitoring of a culture [3].

To address these limitations, recent technological advancements have enabled the integration of optical methods for *in-situ* monitoring. Techniques such as UV–Vis, fluorescence and vibrational (FTIR and Raman) spectroscopy provide accurate and rapid detection for monitoring biomass and cellular compounds in classical photobioreactors (PBRs) [4]. However, these studies mainly focused on a single microalgae species grown in a narrow set of operational conditions and a single target high value compound. Also, different spectroscopic methods have not been compared.
Although the identification of a promising method to monitor microalgae cultures could pave the way to system automation and decrease production costs, a consistent study investigating several microalgae species, high-value compounds and spectral techniques is still missing.

In this PhD thesis several spectral sensors coupled with advanced statistical analysis (chemometrics and machine learning algorithms) will be developed to monitor online microalgae processes (e.g. biomass and molecules production) in photobioreactors. Cell physiology (composition and metabolism) will be fully characterized in order to understand the mechanisms behind the production of the target molecules.

This project will be carried out in the Laboratory of Chemical Engineering and Materials (*LGPM, Bioprocess team*), CentraleSupélec/University Paris-Saclay, Gif-sur-Yvette.

Required skills: Microbial culture, reactors operation, data analysis, spectroscopy.

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How to apply? Please send a CV and a cover letter to Andrea Fanesi and Filipa Lopes using the above-mentioned contact information.

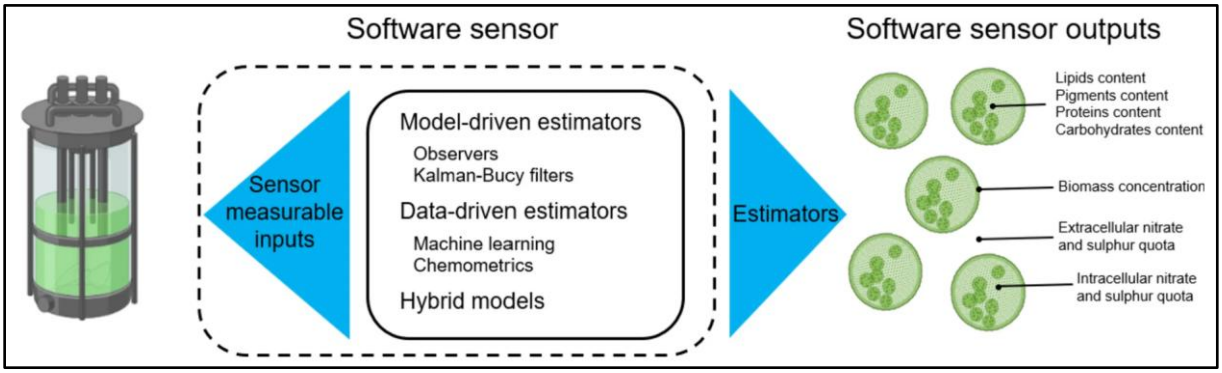

Figure 1. General overview of sensors used for monitoring biological processes in microalgae cultures. Sensors signals are processed using advanced statistical methods to predict valuables culture parameters such as cells macromolecular composition pigments and biomass. Figure taken from [4].

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